

I claim:

1. Liquid processing apparatus comprising:

a liquid containment vessel;

a honeycomb monolith disposed within the vessel, the honeycomb being positioned between a vessel upper collection chamber and a vessel lower collection chamber, the honeycomb incorporating a plurality of open, parallel honeycomb channels connecting the upper and lower chambers;

at least one bypass passageway within the containment vessel connecting the upper and lower chambers for the recirculation of a liquid medium within the vessel; and

mechanical, liquid, or gas bubble agitation means disposed within the vessel for recirculating the liquid medium through the parallel honeycomb channels and bypass passageway.

2. Apparatus in accordance with claim 1 wherein the honeycomb monolith contains or supports a catalyst.

3. Apparatus in accordance with claim 1 wherein the vessel is provided with bubble agitation means.

4. Apparatus in accordance with claim 1 wherein the vessel is provided with both bubble and mechanical agitation means.

5. Apparatus in accordance with claim 1 wherein the by-pass conduit has a cross-sectional area in the range of 10-95% on vessel cross-sections traversing the bypass passageway and the honeycomb.

6. Apparatus in accordance with claim 1 wherein the vessel has a height:diameter ratio of 0.3-100

7. Apparatus in accordance with claim 1 wherein the vessel includes internal or external loop means for transferring heat into or away from the liquid medium disposed in the vessel.

5 8. A chemical reactor for catalytically processing a reactant to produce a product which comprises:

a tank reactor,

a monolithic honeycomb substrate fixedly positioned within said tank,

catalytic material on wall portions of said honeycomb substrate,

10 at least one bypass passageway adjacent said honeycomb substrate within the tank, and

means within said tank for circulating said reactant as or within a liquid medium along the catalyzed wall portions of said honeycomb substrate and through said bypass passageway adjacent said honeycomb substrate to produce a product.

15 9. A reactor in accordance with claim 8 including means for feeding a reactant into said tank, and means for removing a product liquid from said tank.

20 10. A reactor in accordance with claim 8 wherein said monolithic honeycomb substrate has a plurality of channels extending therethrough, and said catalytic material is provided on the wall portions of said channels.

25 11. A reactor in accordance with claim 8 wherein said monolithic honeycomb substrate is in the form of a cylinder fixedly positioned centrally of wall portions of said tank reactor.

30 12. A reactor in accordance with claim 8 wherein said bypass passageway is an annular by-pass passageway extending between inner wall portions of said tank reactor and said cylindrical substrate.

13. A reactor in accordance with claim 12 wherein said internal circulating means is in the form of a blade type agitator positioned in axial alignment with said cylindrical

substrate for circulating the reactant liquid through said catalyzed honeycomb substrate and through said annular bypass passageway extending between wall portions of said tank reactor and said substrate.

5 14. A reactor in accordance with claim 12 wherein said internal circulating means is in the form of a gas feed header type agitator positioned in axial alignment below said cylindrical substrate for forming upwardly flowing bubbles in the reactant liquid and circulating the liquid through said catalyzed honeycomb substrate and through said adjacent annular bypass passageway extending between wall portions of said tank
10 reactor and said substrate.

15 15. A reactor in accordance with claim 14 including means for recirculating and regulating the flow of gas feed to said gas header agitator.

16. A reactor in accordance with claim 8 wherein said monolithic honeycomb substrate is in an annular form fixedly positioned adjacent inner wall portions of said tank.

17. A reactor in accordance with claim 16 wherein said bypass passageway is formed centrally of said annular substrate.

20 18. A reactor in accordance with claim 17 wherein said internal circulating means is in the form of a blade type agitator positioned within said bypass passageway for circulating reactant liquid through said bypass passageway adjacent said substrate and through said catalyzed annular honeycomb substrate.

25 19. A reactor in accordance with claim 17 wherein said internal circulating means is in the form of a gas feed header type agitator positioned adjacent a lower portion of said central bypass passageway for forming upwardly flowing bubbles in reactant liquid within said passageway and circulating such liquid through said central passageway
30 and through the adjacent catalyzed annular honeycomb substrate.

20. A reactor in accordance with claim 17 wherein said internal circulating means includes both a blade agitator and a gas header agitator positioned within said central passageway for circulating reactant liquid through both said central bypass passageway and the adjacent catalyzed annular honeycomb substrate.

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21. A reactor in accordance with claim 17 wherein said internal circulating means is in the form of an annular gas feed header type agitator positioned below said annular honeycomb substrate for forming upwardly flowing bubbles in reactant liquid within the honeycomb and circulating said liquid upwardly through said catalyzed annular honeycomb substrate and downwardly through said bypass passageway centrally of said annular substrate.

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22. A method of producing a product from a reactant within a recirculating tank reactor which comprises,

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feeding a reactant into a tank reactor,

fixedly positioning a monolithic honeycomb substrate having catalytic surfaces within said tank so as to leave room therein for at least one adjacent bypass passageway,

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internally activating a flow of said reactant within said tank,
circulating such activated flow of reactant through said fixedly positioned catalyzed honeycomb substrate and through said adjacent bypass passageway, and
removing a product from said tank reactor.

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23. A method in accordance with claim 22 including the step of internally mechanically activating the flow within the bypass passageway.

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24. A method in accordance with claim 22 wherein the reactant is provided in a liquid medium, and wherein the step of internally activating the flow of reactant comprises forcing gas into designated portions of the liquid medium and forming upwardly flowing bubbles in such portions.

25. A method in accordance with claim 22 including the step of fixedly positioning the monolithic honeycomb substrate adjacent inner sidewall portions of the tank, and forming the adjacent bypass passage centrally of the honeycomb substrate.

5 26. A method in accordance with claim 22 including the step of fixedly positioning the monolithic honeycomb substrate centrally within the tank, and forming the adjacent bypass passageway between the centrally positioned honeycomb substrate and inner wall portions of the tank reactor.

10 27. A stirred tank reactor comprising:

a reactor enclosure having an inlet for the introduction of a reactant into the enclosure and an outlet for the extraction of a product therefrom;

a honeycomb catalyst bed mounted within the enclosure, the bed comprising a plurality of channels extending therethrough;

15 at least one bypass passageway within the enclosure disposed to permit the passage of the reactant and product around and past the honeycomb bed; and

recirculation means comprising a mechanical stirrer positioned within the enclosure for developing a recirculation flow within a liquid medium comprising the reactant present in the reactor, and for carrying at least a portion of the reactant along a closed flow path that sequentially traverses both the honeycomb channels and the
20 bypass passageway.

28. A bubble column reactor comprising:

25 a reactor enclosure having an inlet for the introduction of a reactant into the enclosure and an outlet for the extraction of a product therefrom;

a honeycomb catalyst bed mounted within the enclosure, the bed comprising a plurality of channels extending therethrough;

at least one bypass passageway within the enclosure disposed to permit the passage of the reactant and product around and past the honeycomb bed; and

30 recirculation means comprising a gas bubble source positioned within the enclosure for developing a recirculation flow within a liquid medium comprising the reactant present in the reactor, and for carrying at least a portion of the reactant along a

closed flow path that sequentially traverses both the honeycomb channels and the bypass passageway.